BRIEF DESCRIPTION OF THE DRAWINGS

The various objects and advantages of this invention will become apparent to those skilled in the art upon an understanding of the following detailed description of the invention, read in light of the accompanying drawings which are made a part of this specification and in which::

Figure 1A is a plan view of a FPSO vessel and a yoke moored LNG carrier;

Figure 1 B is a side elevation view of the FPSO vessel and yoke moored LNG carrier;

Figure 2A is a plan view of the yoke of Figure 1A and 1B;

Figure 2B is a side elevation view of the yoke of Figure 2A;

Figure 3 is an elevation view partially in section through the yoke tip;

~~Figures 4, 5, 6, 7, 8, 9, 10 illustrate sequence steps for connecting the LNG carrier to the FPSO;~~

~~Figures 11, 12, and 13 illustrate sequence steps for disconnecting an LNG carrier from a FPSO;~~

~~Figure 14 illustrates an alternative arrangement of the yoke tip;~~

Figure 4A shows a carrier vessel which has approached a FPSO process vessel for temporary mooring and offloading thereto;

Figure 5A shows hawsers from the FPSO process vessel retrieved by the carrier vessel and a messenger rope on the carrier vessel for retrieval of a floating rope connected to a chain windlass;

Figure 5B shows a chain windlass on the yoke of the process vessel with a chain which has been retrieved by a chain pull-in rope from the carrier vessel;

Figures 6A and 6B show the yoke floating in the sea while the chain is being pulled into the connector of Figure 3;

Figures 7A and 7B show a plan and side view respectively of the yoke tip approaching the connector on the end of the carrier vessel;

Figure 8A shows a guide cone of a male connector at the tip of the yoke approaching the female connector at the end of the carrier vessel;

Figure 8B shows the guide cone of the tip of the yoke almost fully connected to the female connector of the carrier vessel;

Figure 9A shows the yoke end connector fully connected to the carrier vessel in preparation for hydrocarbon transfer from the FPSO process vessel to the carrier vessel;

Figure 9B shows a piping pantograph being pulled toward a transfer connector on the carrier vessel;

Figure 10 shows the piping pantograph fully connected to the carrier vessel;

Figure 11A shows an operating condition where the carrier vessel is moored via a yoke, yet the carrier vessel is offset longitudinally from the FPSO vessel;

Figure 11B shows the pantograph disconnected from the carrier vessel, while the carrier vessel continues to be connected to the yoke;

Figure 12A shows the connector of the yoke disconnected from the connector of the carrier vessel, but with the yoke floating in the sea;

Figure 12B shows the carrier vessel that has moved away from the FPSO process vessel;

Figure 13A shows the yoke beginning to be lifted out of the sea;

Figure 13B shows the yoke lifted to its storage position out of the sea;

Figures 14A and 14B show a plan and side view respectively of an alternative arrangement for a yoke tip connector;

Figure 15 is an elevation view of an alternative yoke mooring arrangement with a windlass mounted on the LNG/FPSO vessel pulling a rope for connecting the LNG to the FPSO;

Figures 16A and 16B respectively illustrate details of the mating receiver on the bow extension of the LNG carrier vessel and a mating cone and yoke tip with a pull-in line passing through a U-joint of the mating cone;

Figure 16C is a partially cut-away perspective view of the mating cone of the yoke tip locked to a connector which illustrates connection of the mating cone to a three-axis gimbaled joint and connection of the mating cone to a hydraulic connector on an extension of the vessel; and

Figure 16D illustrates the mating cone locked to a connector with a yaw bearing and a flex joint substituted for the gimbaled joint of Figure 16C.

occurring in rope 110 cause moveable sheave 130 and sheave frame 134 to be lifted upward thereby compressing elastomeric spring 120.

Spring 120 is a commercially available component typically used for dock bumpers for berthing ships. Compression of spring 120 absorbs large quantities of energy, thereby greatly reducing the peak loads in rope 110. Spring 120 is firmly attached to support bracket 136 to transmit rope 110 loads into yoke structure 16.

Figures 15 through 18 illustrates another embodiment of the invention where a rope winch 100′ is positioned not on the yoke itself, but on the stern of the vessel 1 in the vicinity of winch 11a but near the centerline of vessel 1. The tension member 110 in this embodiment is a high strength synthetic fiber rope as described above, and is wound around rope sheaves 140, 142 and 144 and is terminated in an end fitting 19′ as shown in Figure 16B. Figure 16A illustrates the receiver 34′ carried by extension or connection module 8. A hydraulic connector 42′ is secured on connection module 8 to selectively capture end fitting 19′ when it is pulled upward by messenger line 40′ similar to the illustration of Figures 2B and 3. Figure 16C illustrates, in a cross-section cut away elevation drawing, the mating cone 32′ via cone extension member 32″ locked in the connector 42′ after it has been fully pulled in and locked. The mating cone 32′ is carried on a two-axis gimbaled joint 90 with an internal vertical axis yaw bearing 91 which allows the cone 32′ and cone extension member 32″ to rotate about a vertical axis through a center line through pedestal 35. An elastomeric flex joint can be substituted for the two-axis gimbaled joint. Such a flex joint can be a universal type (Hooke's joint) or a tapered stress joint of metallic or composite construction, or a flex joint 92 (see Figure 16D) using metallic or composite materials. Cone extension member 32″ is sized ~~for~~ to allow rope 110 to pass through its center (see Figure 16B) and has an outer profile 92 arranged with grooves so that locking members or dogs 80 of connector 42 can lock yoke tip 15′ to receiver 34′.